We claim:

1. A waveguide photodetector comprising:

a waveguide comprising:

a core comprised of a germanium on silicon heterojunction, and

a cladding comprised of a plurality of dielectric materials,

a first plurality of conductive contacts coupled to the germanium, and

a second plurality of conductive contacts coupled to the silicon.

2. The waveguide photodetector of claim 1, further comprising the fabrication of a transistor body at the same time as the fabrication of the silicon of the heterojunction.

3. The waveguide photodetector of claim 1, wherein the germanium on silicon heterojunction forms a diode structure with a depletion region, where the diode structure is capable of producing and separating electron hole pairs caused by photons absorbed in the depletion region.

4. The waveguide photodetector of claim 1, wherein the germanium is selected from the group comprising monocrystalline germanium and polycrystalline germanium.

5. The waveguide photodetector of claim 1, wherein the cladding further comprises: a bottom cladding, a side cladding and a top cladding, where each of the claddings is comprised of a plurality of dielectric materials.

6. The waveguide photodetector of claim 5, wherein one of the plurality of dielectric materials comprising a layer of side cladding is formed from the same film as a dielectric component of a transistor, where the dielectric component is selected from a group comprising: an inter-layer dielectric film, a gate spacer, a silicide block, a dielectric spacer, a passivation film, an isolation dielectric and a field oxide.

7. The waveguide photodetector of claim 5, wherein one of the plurality of dielectric materials comprising a layer of top cladding is formed from the same film as a dielectric component of a transistor, where the dielectric component is selected from a group comprising: an inter-layer dielectric film, a gate spacer, a silicide block, a dielectric spacer and a passivation film.

8. The waveguide photodetector of claim 5, wherein the bottom cladding is comprised of the insulating layer of a substrate, where the substrate is selected from the group comprising: silicon on insulator (SOI), silicon on sapphire (SOS) and a silicon membrane (also known as silicon on nothing, SON).

9. The waveguide photodetector of claim 5, further comprising the fabrication of the insulator of a SOI substrate of an integrated circuit at the same time as the fabrication of the bottom cladding of the waveguide.

10. The waveguide photodetector of claim 9, wherein the integrated circuit is selected from the group comprising: a CMOS integrated circuit, a BiCMOS integrated circuit and a bipolar junction integrated circuit.

11. The waveguide photodetector of claim 1, wherein at least one of the plurality of dielectric materials is selected from the group comprising: SiO_2, SiCOH, SiCOF, Si_3N_4, SiON, BPSG and silicon-based materials including one or more of the following elements: oxygen, carbon, nitrogen, hydrogen, boron, phosphorus, fluorine and arsenic.

12. The waveguide photodetector of claim 1, wherein each of the second plurality of conductive contacts comprises:
an ohmic contact to the silicon of the heterojunction, and
a conductive plug with a first terminal coupled to the ohmic contact and a second terminal coupled to a metal layer of an integrated circuit.

13. The waveguide photodetector of claim 12, wherein the conductive plug is formed simultaneously with the metal layer.

14. The waveguide photodetector of claim 12, further comprising the fabrication of an ohmic contact on a terminal region of a transistor at the same time as the fabrication of an ohmic contact on the silicon of the heterojunction, where the terminal region of a transistor is selected from a group comprising: a source, a drain, a gate and a body.

15. The waveguide photodetector of claim 12, further comprising the fabrication of a conductive plug to an ohmic contact of a transistor at the same time as the fabrication of a conductive plug to an ohmic contact to the silicon of the heterojunction.

16. The waveguide photodetector of claim 12, wherein an ohmic contact is comprised of a metal silicide.

17. The waveguide photodetector of claim 12, wherein a conductive plug is comprised of tungsten.

18. The waveguide photodetector of claim 12, further comprising fabrication of a local interconnection between a pair of transistors, at the same time as fabricating a local interconnection for coupling an ohmic contact on the silicon of the heterojunction with an ohmic contact on a transistor.

19. The waveguide photodetector of claim 18, wherein the local interconnection is comprised of a material selected from the group comprising: tungsten and aluminum.

20. The waveguide photodetector of claim 1, wherein at least one contact of the pluralities of contacts is coupled to a metal layer on an integrated circuit, where the metal layer has a coupling to an element on the integrated circuit and where the element is selected from the group comprising: a capacitor, a resistor, an inductor, a diode, a transistor and a bond pad.

21. The waveguide photodetector of claim 1, wherein each of the first plurality of conductive contacts comprises:
an ohmic contact to the germanium of the heterojunction, and
a conductive plug with a first terminal coupled to the ohmic contact and a second terminal coupled to a metal layer of an integrated circuit.

22. The waveguide photodetector of claim 1, further comprising the introduction of a plurality of dopants into a plurality of regions in the silicon of the heterojunction.

23. The waveguide photodetector of claim 22, further comprising the introduction of a plurality of dopants into a plurality of regions in the silicon body of a transistor at the same time as the introduction of the plurality of dopants into a plurality of regions in the silicon of the heterojunction.

24. The waveguide photodetector of claim 1, further comprising the introduction of a plurality of dopants into a plurality of regions in the germanium of the heterojunction.

25. The waveguide photodetector of claim 1, further comprising the introduction of a first plurality of dopants into a plurality of regions in the silicon of the heterojunction, and the introduction of a second plurality of dopants into a plurality of regions in the germanium of the heterojunction.

26. The waveguide photodetector of claim 25, wherein the first plurality of dopants is comprised of dopants with electrical charge opposite to the polarity of the dopants comprising the second plurality of dopants.

27. The waveguide photodetector of claim 25, wherein the first plurality of dopants is comprised of dopants with electrical charge equal to the polarity of the dopants comprising the second plurality of dopants.

28. The waveguide photodetector of claim 1, further comprising an input to the waveguide photodetector.

29. The waveguide photodetector of claim 28, further comprising a silicon waveguide with an input and an output, where the output of the silicon waveguide is coupled to the input of the waveguide photodetector.

30. The waveguide photodetector of claim 28, further comprising a mode converter with an input and an output, where the output of the mode converter is coupled to the input of the waveguide photodetector, and where the input to the mode converter is coupled to the output of the silicon waveguide.

31. The waveguide photodetector of claim 30, wherein the mode converter is comprised of a polysilicon optical structure.

32. The waveguide photodetector of claim 31, further comprising the fabrication of a polysilicon gate for a transistor at the same time as the fabrication of the polysilicon optical structure.

33. The waveguide photodetector of claim 30, wherein the mode converter is comprised of a plurality of dielectric structures introduced in substantial proximity to the input to the waveguide photodetector.

34. The waveguide photodetector of any of claims 2, 6, 7, 10, 14, 15, 18, 20, 21, 23 and 32, wherein the transistor is selected from the group comprising: a CMOS transistor, a BiCMOS transistor, a bipolar junction transistor (BJT) and a junction FET (JFET) transistor.

35. The waveguide photodetector of claim 34, wherein the CMOS transistor is selected from the group of transistors comprising: a fully depleted CMOS transistor, a partially depleted CMOS transistor, a floating body CMOS transistor and a body tied CMOS transistor.

36. A method for communicating signals to a semiconductor device using optical signals comprising:

sending an optical signal to an input of a germanium on silicon waveguide photodetector located on a semiconductor chip, and

outputting an electrical signal from an output of the germanium-on-silicon waveguide photodetector to the input of a semiconductor device located on the semiconductor chip.

37. A method for communicating signals to a semiconductor device using optical signals comprising:

receiving an optical signal at an input of a germanium on silicon waveguide photodetector located on a semiconductor chip, and

outputting an electrical signal from an output of the germanium-on-silicon waveguide photodetector to the input of a semiconductor device located on the semiconductor chip.

38. A semiconductor chip comprising:

a germanium on silicon waveguide photodetector with inputs for receiving optical signals, outputs for outputting electrical signals, and located on the semiconductor chip, and

a semiconductor device connected to the germanium on silicon waveguide photodetector outputs and located on the semiconductor chip.

39. A data structure representation of a germanium on silicon waveguide photodetector, the germanium on silicon waveguide photodetector comprising:

a data structure representation of a waveguide comprising:

a data structure representation of a core comprised of a germanium on silicon heterojunction, and

a data structure representation of a cladding comprised of a plurality of dielectric materials.

a data structure representation of a first plurality of conductive contacts coupled to the germanium, and

a data structure representation of a second plurality of conductive contacts coupled to the silicon.

40. The data structure representation of a germanium on silicon waveguide photodetector as claimed in claim 39, wherein the data structure representation is selected from a list consisting of a component in a software library having a fixed specification for an integrated circuit netlist, a netlist, a CAD (computer-aided design) representation, and a hardware definition language representation.

41. The data structure representing a germanium on silicon waveguide photodetector as claimed in claim 39, wherein the data structure further represents an integrated circuit.

42. A plurality of maskworks comprising a pattern of opaque and transparent areas adapted to define a germanium on silicon waveguide photodetector comprising;

a waveguide comprising:

a core comprised of a germanium on silicon heterojunction, and

a cladding comprised of a plurality of dielectric materials.

a first plurality of conductive contacts coupled to the germanium, and

a second plurality of conductive contacts coupled to the silicon.

43. The maskwork for creating a germanium-on-silicon waveguide photodetector as claimed in claim 42, wherein the maskwork can be used to create an integrated circuit.